CONTENTS

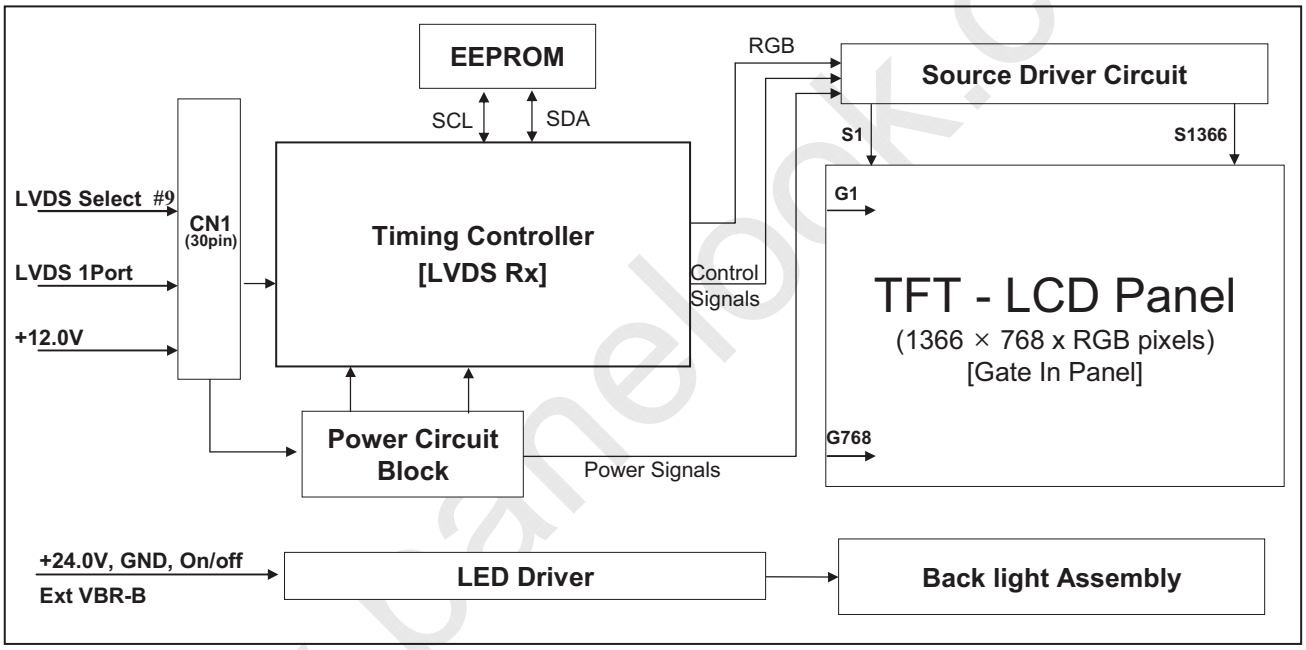
Number	ITEM	Page
	COVER	1
	CONTENTS	2
	RECORD OF REVISIONS	3
1	GENERAL DESCRIPTION	4
2	ABSOLUTE MAXIMUM RATINGS	5
3	ELECTRICAL SPECIFICATIONS	6
3-1	ELECTRICAL CHARACTERISTICS	6
3-2	INTERFACE CONNECTIONS	8
3-3	SIGNAL TIMING SPECIFICATIONS	10
3-4	LVDS SIGNAL SPECIFICATIONS	11
3-5	COLOR DATA REFERENCE	14
3-6	POWER SEQUENCE	15
4	OPTICAL SPECIFICATIONS	17
5	MECHANICAL CHARACTERISTICS	21
6	RELIABILITY	24
7	INTERNATIONAL STANDARDS	25
7-1	SAFETY	25
7-2	EMC	25
7-3	ENVIRONMENT	25
8	PACKING	26
8-1	DESIGNATION OF LOT MARK	26
8-2	PACKING FORM	26
9	PRECAUTIONS	27
9-1	MOUNTING PRECAUTIONS	27
9-2	OPERATING PRECAUTIONS	27
9-3	ELECTROSTATIC DISCHARGE CONTROL	27
9-4	PRECAUTIONS FOR STRONG LIGHT EXPOSURE	27
9-5	STORAGE	27
9-6	HANDLING PRECAUTIONS FOR PROTECTION FILM	27

RECORD OF REVISIONS

Revision No.	Revision Date	Page	Description
0.1	17th Jan. 2012	-	Preliminary Specification (First Draft)

1. General Description

The LC320EXN is a Color Active Matrix Liquid Crystal Display with an integral Light Emitting Diode (LED) backlight system. The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive display type which is operating in the normally black mode. It has a 31.51 inch diagonally measured active display area with WXGA resolution (768 vertical by 1366 horizontal pixel array). Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arranged in Horizontal stripes. Gray scale or the luminance of the sub-pixel color is determined with a 8-bit gray scale signal for each dot, thus presenting a palette of more than 16.7M(6bit + A-FRC) colors.
It has been designed to apply the 8-bit 1-port LVDS interface.
It is intended to support LCD TV, PCTV where high brightness, super wide viewing angle, high color gamut, high color depth and fast response time are important.



General Features

Active Screen Size	31.51 inches(800.4mm) diagonal
Outline Dimension	735.4 mm(H) x 433.0 mm(V) x 10.8 mm(D) (Typ.)
Pixel Pitch	170.25㎛ x 510.75㎛ x RGB
Pixel Format	1366 horiz. by 768 vert. pixels RGB stripe arrangement
Color Depth	8bit(D), 16,7 M colors
Luminance, White	350 cd/m^2 (Center 1 point) (Typ.)
Viewing Angle (CR>10)	Viewing angle free (R/L 178(Min.), U/D 178(Min.))
Power Consumption	Total 36.0 Watt (Logic=4.1 W , LED Driver =31.9W @ [ExtVbr_B=100%])
Weight	5,350g (Typ.TBD) 5,620g (Max,TBD)
Display Operating Mode	Transmissive mode, normally black
Surface Treatment	Hard coating(3H), Anti-glare treatment of the front polarizer (Haze 1%)

2. Absolute Maximum Ratings

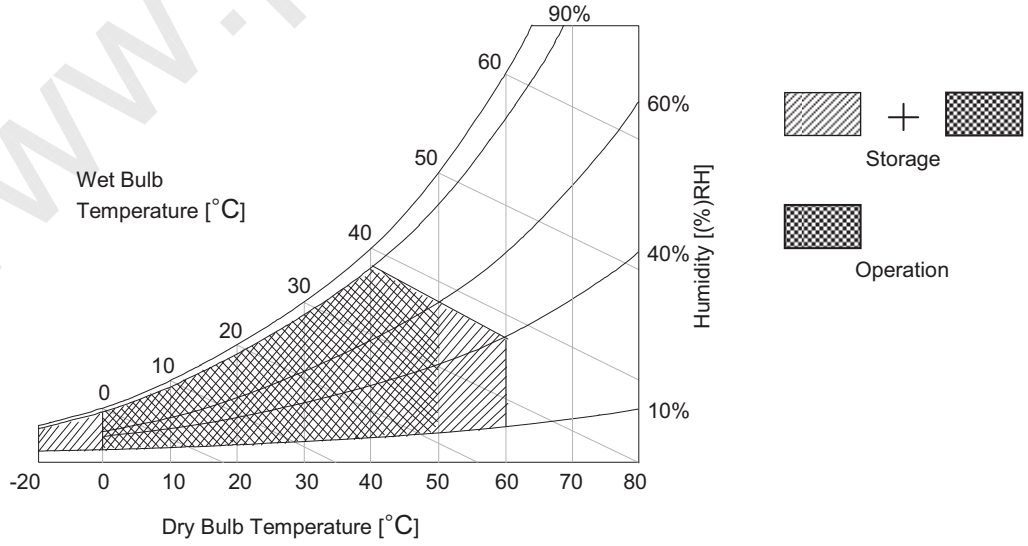
The following items are maximum values which, if exceeded, may cause faulty operation or permanent damage to the LCD module.

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter		Symbol	Value		Unit	Note
			Min	Max		
Power Input Voltage	LCD Circuit	V_{LCD}	-0.3	+14.0	V_{DC}	1
	Driver	V_{BL}	-0.3	+ 27.0	V_{DC}	
Driver Control Voltage	ON/OFF	V_{OFF} / V_{ON}	-0.3	+5.5	V_{DC}	
	Brightness	V_{BR}	0.0	+5.5	V_{DC}	
T-Con Option Selection Voltage		V_{LOGIC}	-0.3	+4.0	V_{DC}	
Operating Temperature		T_{OP}	0	+50	°C	2,3
Storage Temperature		T_{ST}	-20	+60	°C	
Panel Front Temperature		T_{SUR}	-	+68	°C	4
Operating Ambient Humidity		H_{OP}	10	90	%RH	2,3
Storage Humidity		H_{ST}	10	90	%RH	

Note1. Ambient temperature condition (Ta = 25 ± 2 °C)

2. Temperature and relative humidity range are shown in the figure below.
   Wet bulb temperature should be Max 39°C, and no condensation of water.
3. Gravity mura can be guaranteed below 40°C condition.
4. The maximum operating temperatures is based on the test condition that the surface temperature of display area is less than or equal to 68°C with LCD module alone in a temperature controlled chamber. Thermal management should be considered in final product design to prevent the surface temperature of display area from being over 68℃. The range of operating temperature may be degraded in case of improper thermal management in final product design.



3. Electrical Specifications

3-1. Electrical Characteristics

It requires two power inputs. One is employed to power for the LCD circuit. The other Is used for the LED backlight and LED Driver circuit.

Table 2. ELECTRICAL CHARACTERISTICS

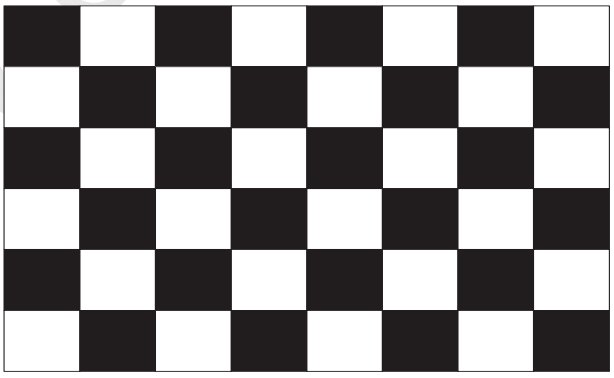
Parameter	Symbol	Value			Unit	Note
		Min	Typ	Max		
Circuit :						
Power Input Voltage	V_{LCD}	10.8	12.0	13.2	V_{DC}	
Power Input Current	I_{LCD}	-	340	445	mA	1
		-	430	560	mA	2
Power Consumption	P_{LCD}	-	4.08	5.30	Watt	1
Rush current	I_{RUSH}	-	-	3.0	A	3

Notes : 1. The specified current and power consumption are under the V_{LCD}=12.0V, 25 ± 2°C, f_V=60Hz condition and mosaic pattern(8 x 6) is displayed and f_V is the frame frequency.

2. The current is specified at maximum current pattern.

3. The duration of rush current is about 2ms and rising time of power input is 0.5ms (min.).

White : 255 Gray
Black : 0 Gray



Mosaic Pattern(8 x 6)

Table 3. ELECTRICAL CHARACTERISTICS (Continue)

Parameter			Symbol	Values			Unit	Notes
				Min	Typ	Max		
LED Driver :								
Power Supply Input Voltage			VBL	22.8	24.0	25.2	Vdc	1
Power Supply Input Current			IBL_A	-	1.33	1.45	A	Ext V_{BR-B} = 100%
Power Supply Input Current (In-Rush)			Irush	-	-	3	A	V_{BL} = 22.8V Ext V_{BR-B} = 100% 4
Power Consumption			PBL	-	31.9	34.8	W	Ext V_{BR-B} = 100%
	On/Off	On	V on	2.5	-	5.0	Vdc	
		Off	V off	-0.3	0.0	0.7	Vdc	
	Brightness Adjust		ExtVBR-B	5	-	100	%	On Duty 6
				1	-	100		
	PWM Frequency for NTSC & PAL		PAL		100		Hz	3
			NTSC		120		Hz	3
	Pulse Duty Level (PWM)		High Level	2.5	-	5.0	Vdc	HIGH : on duty LOW : off duty
			Low Level	0.0	-	0.7	Vdc	
LED :								
Life Time				30,000	50,000		Hrs	2

Notes :

1. Electrical characteristics are determined after the unit has been 'ON' and stable for approximately 60 minutes at 25±2°C. The specified current and power consumption are under the typical supply Input voltage 24Vand V_{BR} (ExtV_{BR-B} : 100%), it is total power consumption.
2. The life time (MTTF) is determined as the time which luminance of the LED is 50% compared to that of initial value at the typical LED current (ExtVBR-B :100%) on condition of continuous operating in LCM state at 25±2°C.
3. LGD recommend that the PWM freq. is synchronized with Two time harmonic of V_sync signal of system. Though PWM frequency is over 120Hz (max 252Hz), function of LED Driver is not affected.
4. The duration of rush current is about 200ms. This duration is applied to LED on time.
5. Even though inrush current is over the specified value, there is no problem if I^2T spec of fuse is satisfied.
6. ExtV_{BR-B} signal have to input available duty range and sequence.
   After Driver ON signal is applied, ExtV_{BR-B} should be sustained from 5% to 100% more than 500ms.
   After that, ExtV_{BR-B} 1% and 100% is possible
   For more information, please see 3-6-2. Sequence for LED Driver.

3-2. Interface Connections

This LCD module employs two kinds of interface connection, a 30-pin connector is used for the module electronics and 14-pin connector is used for the integral backlight system.

3-2-1. LCD Module

- LCD Connector(CN1) : KDF71G-30S-1H(Hirose) or FI-X30SSL-HF(JAE)
- Mating Connector : : FI-X30C2L (Manufactured by JAE) or Equivalente

Table 4. MODULE CONNECTOR(CN1) PIN CONFIGURATION

Pin No.	Symbol	Description	Note
1	VLCD	Power Supply +12.0V	
2	VLCD	Power Supply +12.0V	
3	VLCD	Power Supply +12.0V	
4	VLCD	Power Supply +12.0V	
5	GND	Ground	
6	GND	Ground	
7	GND	Ground	
8	GND	Ground	
9	LVDS Select	'H' =JEIDA , 'L' or NC = VESA	Appendix IV
10	NC	No Connection	4
11	GND	Ground	
12	RA-	LVDS Receiver Signal(-)	
13	RA+	LVDS Receiver Signal(+)	
14	GND	Ground	
15	RB-	LVDS Receiver Signal(-)	
16	RB+	LVDS Receiver Signal(+)	
17	GND	Ground	
18	RC-	LVDS Receiver Signal(-)	
19	RC+	LVDS Receiver Signal(+)	
20	GND	Ground	
21	RCLK-	LVDS Receiver Clock Signal(-)	
22	RCLK+	LVDS Receiver Clock Signal(+)	
23	GND	Ground	
24	RD-	LVDS Receiver Signal(-)	
25	RD+	LVDS Receiver Signal(+)	
26	GND	Ground	
27	NC	No Connection	4
28	NC	No Connection	4
29	NC	No Connection	**4**
30	GND	Ground	

Notes :
1. All GND (Ground) pins should be connected together to the LCD module's metal frame.
2. All VLCD (power input) pins should be connected together.
3. All Input levels of LVDS signals are based on the EIA 644 Standard.
4. These pins are used only for LGD (Do not connect)
5. Specific pin No. #30 is used for "No signal detection" of system signal interface.
   It should be GND for NSB (No Signal Black) while the system interface signal is not.
   If this pin is "H", LCD Module displays AGP (Auto Generation Pattern).

3-2-2. Backlight Module

Master

-LED Driver Connector

: 20022WR - H14B2(Yeonho)

-.Mating Connector

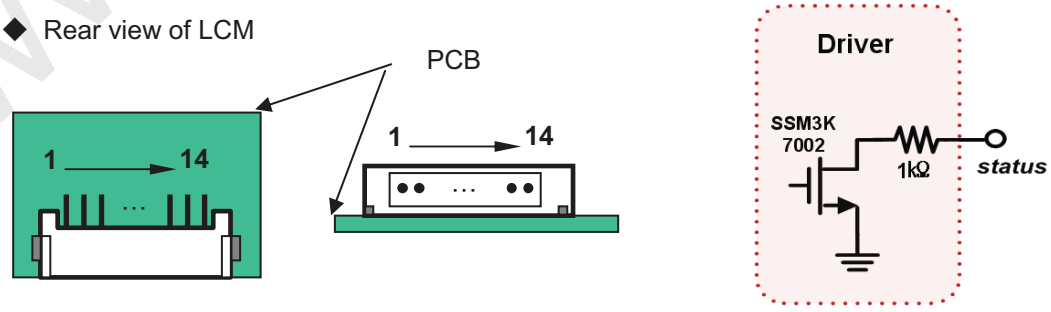
: 20022HS - 14B2 or Compatible

Table 5. LED DRIVER CONNECTOR PIN CONFIGURATION

Pin No	Symbol	Description	Note
1	VBL	Power Supply +24.0V	
2	VBL	Power Supply +24.0V	
3	VBL	Power Supply +24.0V	
4	VBL	Power Supply +24.0V	
5	VBL	Power Supply +24.0V	
6	GND	Backlight Ground	
7	GND	Backlight Ground	
8	GND	Backlight Ground	1
9	GND	Backlight Ground	
10	GND	Backlight Ground	
11	Status	Back Light Status	2
12	VON/OFF	Backlight ON/OFF control	
13	NC	Don't care	
14	EXTVBR-B	External PWM	

Notes : 1. GND should be connected to the LCD module's metal frame.
2. Normal : Low (under 0.7V) / Abnormal : Open
3. High : on duty / Low : off duty, Pin#14 can be opened. (if Pin #14 is open , EXTVBR-B is 100%)
4. Each impedance of pin #12 and 14 is over 50 [KΩ] .

◆ Rear view of LCM



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3-3. Signal Timing Specifications

Table 6 shows the signal timing required at the input of the LVDS transmitter. All of the interface signal timings should be satisfied with the following specification for normal operation.

Table 6-1. TIMING TABLE (DE Only Mode)

ITEM		Symbol	Min	Typ	Max	Unit	Note
Horizontal	Display Period	tHV	-	1366	-	tclk	
	Blank	tHB	90	162	410	tclk	
	Total	tHP	1456	1528	1776	tclk	
Vertical	Display Period	tVV	-	768	-	tHP	
	Blank	tVB	20 (126)	22 (180)	240 (295)	tHP	1
	Total	tVP	788 (894)	790 (948)	1008 (1063)	tHP	

ITEM		Symbol	Min	Typ	Max	Unit	Note
Frequency	DCLK	fCLK	63.0	72.4	80.0	MHz	
	Horizontal	fH	45	47.4	55	KHz	2
	Vertical	fV	57 (47)	60 (50)	63 (53)	Hz	2 NTSC : 57~63Hz (PAL : 47~53Hz)

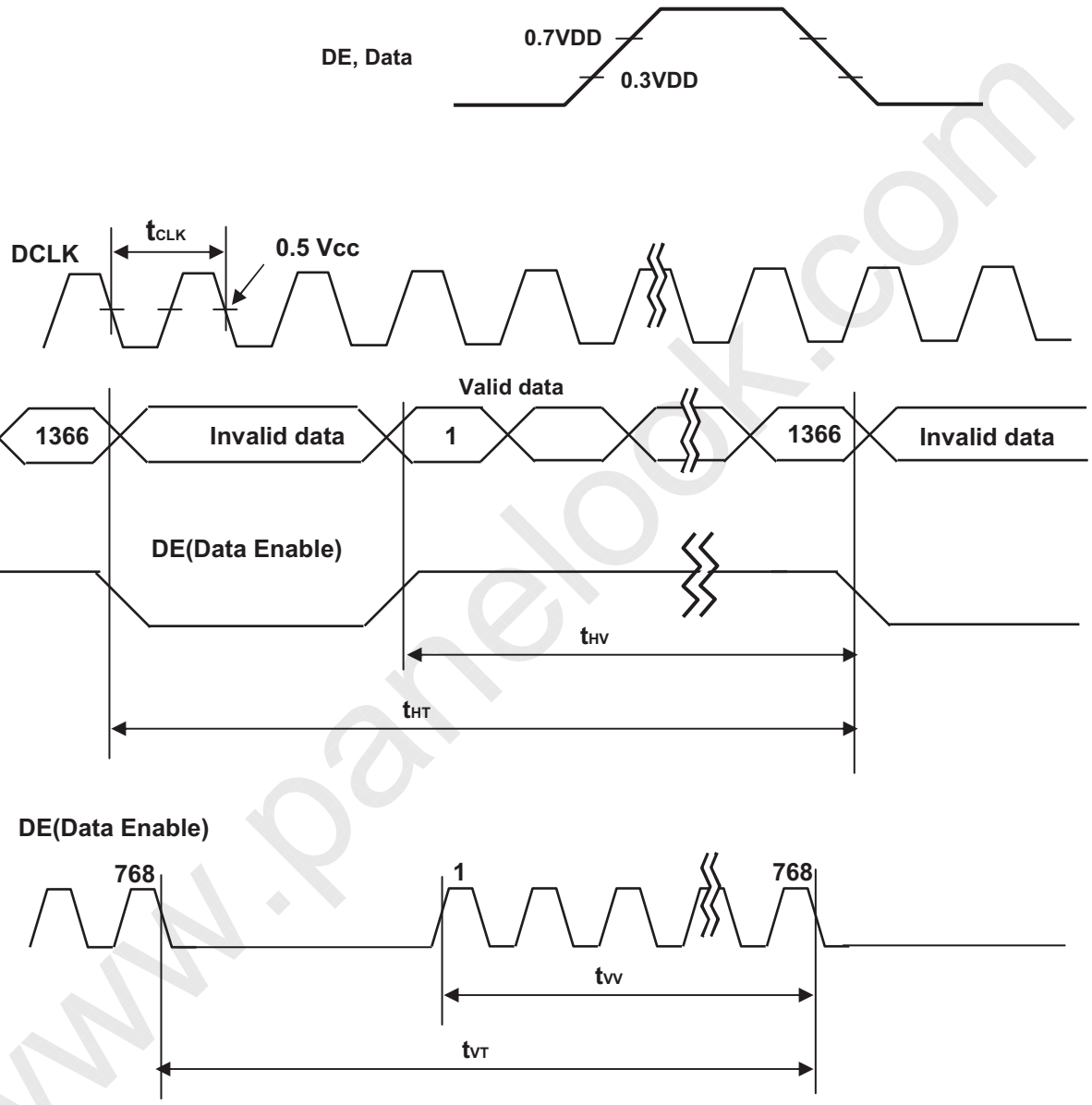
Note: 1. The input of HSYNC & VSYNC signal does not have an effect on normal operation (DE Only Mode). If you use spread spectrum of EMI, add some additional clock to minimum value for clock margin.

2. The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rate and the horizontal frequency

※ Timing should be set based on clock frequency.

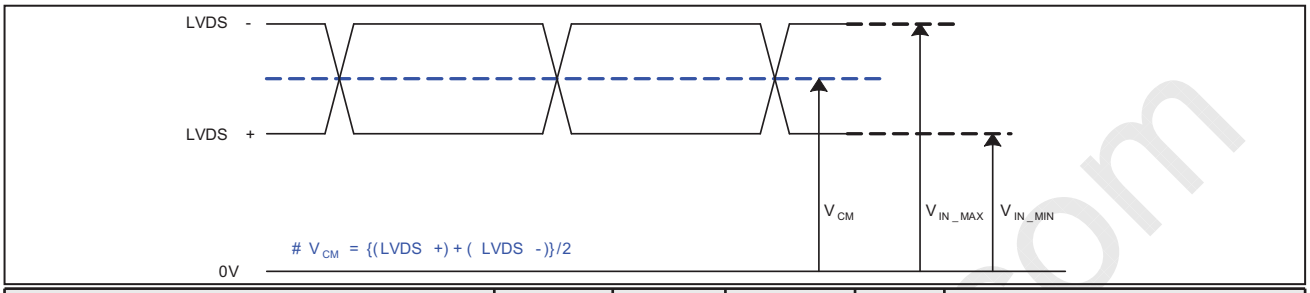
3-4. Signal Timing Waveforms

3-4-1. LVDS Input Signal Timing Diagram



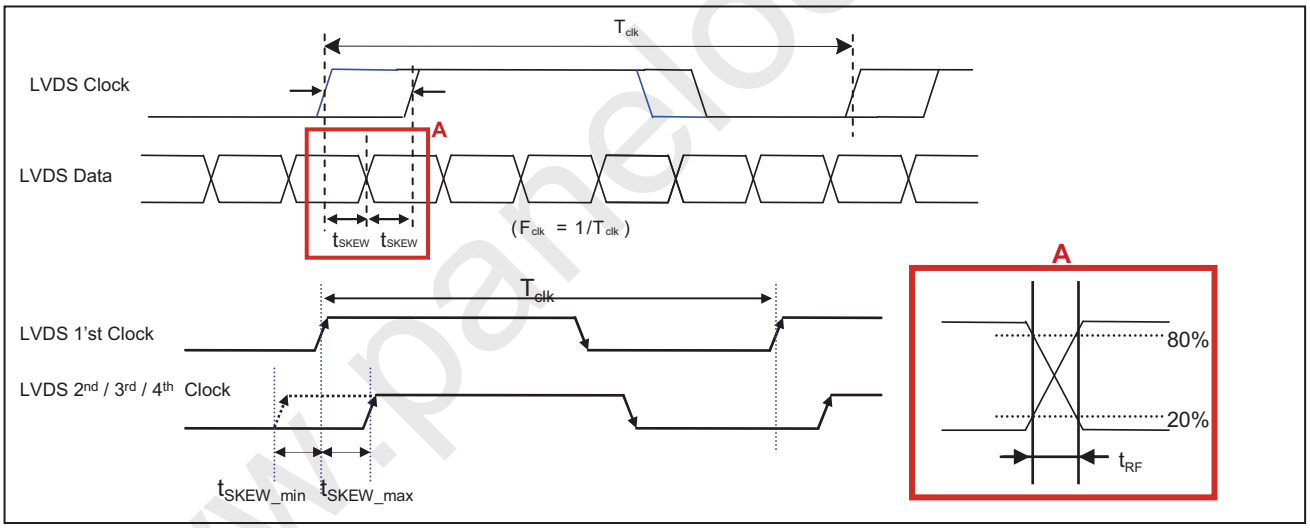
3-4-2. LVDS Input Signal Characteristics

1) DC Specification



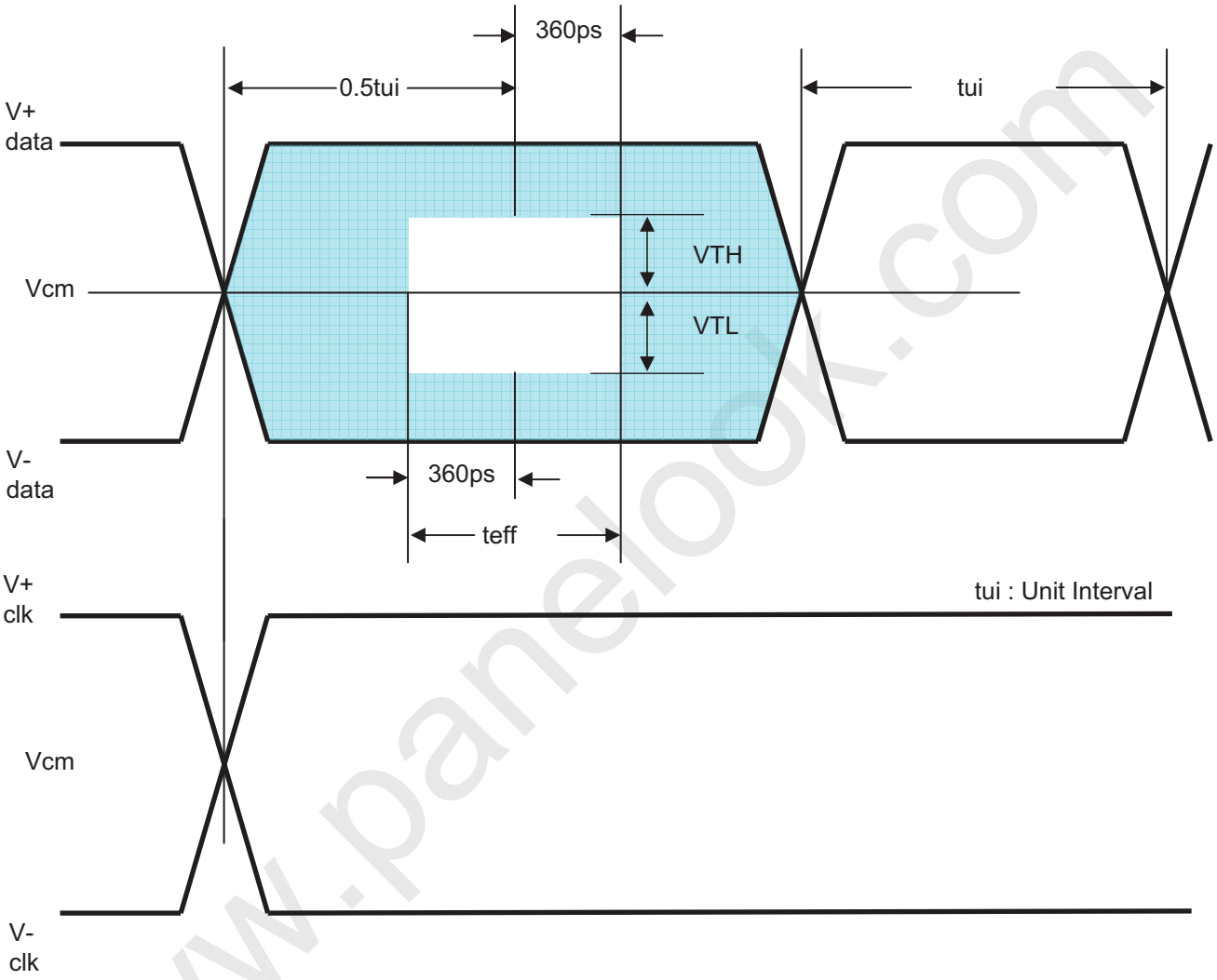
Description	Symbol	Min	Max	Unit	Note
LVDS Common mode Voltage	V_{CM}	1.0	1.5	V	-
LVDS Input Voltage Range	V_{IN}	0.7	1.8	V	-
Change in common mode Voltage	ΔVCM	-	250	mV	-

2) AC Specification



Description		Symbol	Min	Max	Unit	Note
LVDS Differential Voltage	High Threshold	V_{TH}	100	300	mV	3
	Low Threshold	V_{TL}	-300	-100	mV	
LVDS Clock to Data Skew		t_{SKEW}	-	$\lvert(0.20*T_{clk})/7\rvert$	ps	-
LVDS Clock/DATA Rising/Falling time		t_{RF}	260	$\lvert(0.3*T_{clk})/7\rvert$	ps	2
Effective time of LVDS		t_{eff}	$\lvert\pm360\rvert$	-	ps	-
LVDS Clock to Clock Skew (Even to Odd)		t_{SKEW_EO}	-	$\lvert1/7* T_{clk}\rvert$	ps	-

Note 1. All Input levels of LVDS signals are based on the EIA 644 Standard.
2. If t_{RF} isn't enough, t_{eff} should be meet the range.
3. LVDS Differential Voltage is defined within t_{eff}



3-5. Color Data Reference

The brightness of each primary color (Red, Green, Blue) is based on the 8-bit gray scale data input for the color. The higher binary input, the brighter the color. Table 7 provides a reference for color versus data input.

Table 7. COLOR DATA REFERENCE

Color		Input Color Data																			
		RED								GREEN								BLUE							
		MSB							LSB	MSB							LSB	MSB							LSB
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
Basic Color	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red (255)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green (255)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Blue (255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Cyan	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Magenta	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
RED	RED (000) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (001)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	...					...								...								...			
	RED (254)	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (255)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GREEN	GREEN (000) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN (001)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	...					...								...								...			
	GREEN (254)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
	GREEN (255)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
BLUE	BLUE (000) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BLUE (001)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	...					...								...								...			
	BLUE (254)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0
	BLUE (255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

3-6. Power Sequence

3-6-1. LCD Driving circuit

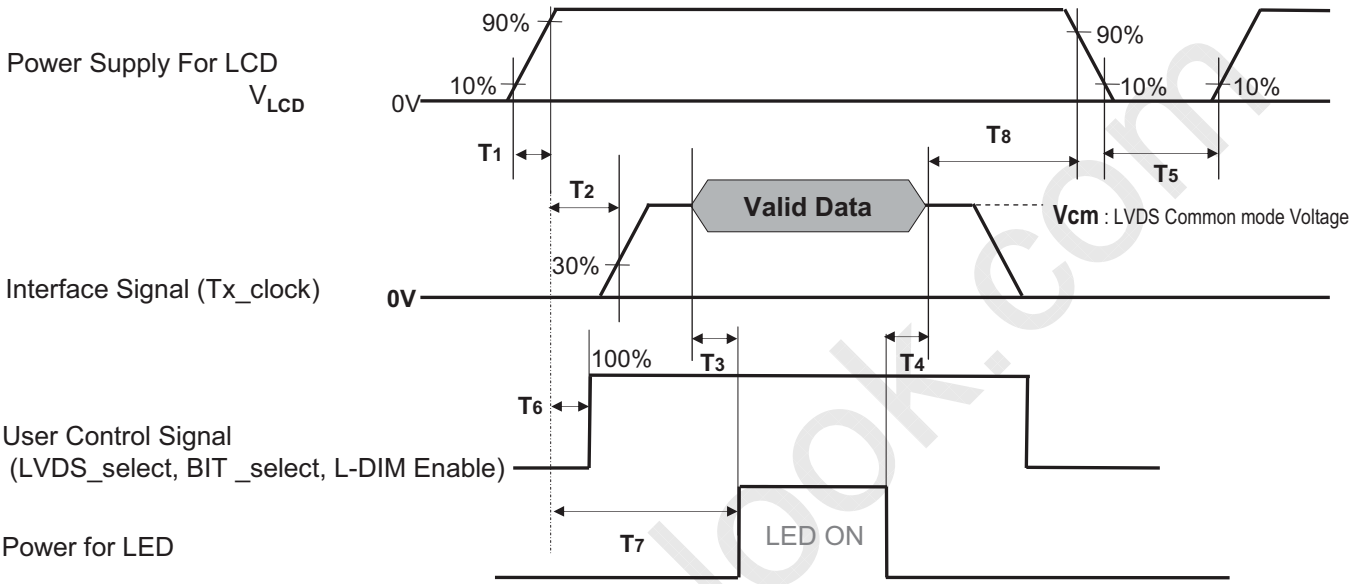


Table 8. POWER SEQUENCE

Parameter	Value			Unit	Notes
	Min	Typ	Max		
T1	0.5	-	20	ms	1
T2	0	-	-	ms	2
T3	200	-	-	ms	3
T4	200	-	-	ms	3
T5	1.0	-	-	s	4
T6	-	-	T2	ms	5
T7	0.5	-	-	s	6
T8	100	-	-	ms	7

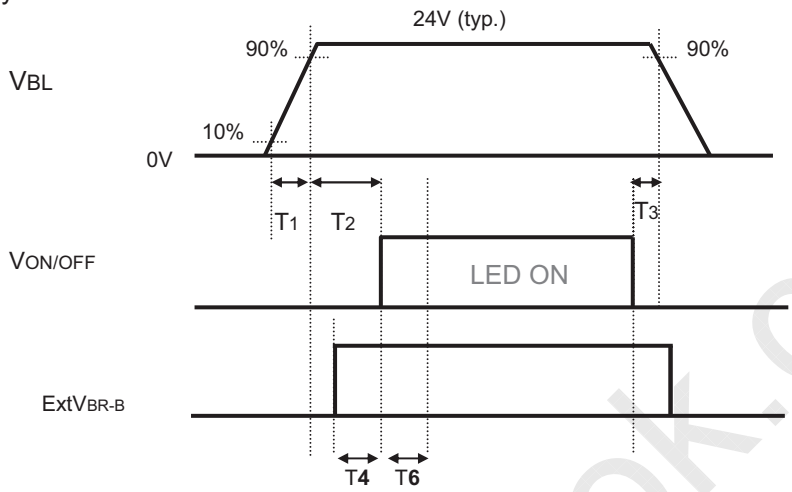
Note :

1. Even though T1 is over the specified value, there is no problem if I2T spec of fuse is satisfied.
2. If T2 is satisfied with specification after removing LVDS Cable, there is no problem.
3. The T3 / T4 is recommended value, the case when failed to meet a minimum specification, abnormal display would be shown. There is no reliability problem.
4. T5 should be measured after the Module has been fully discharged between power off and on period.
5. If the on time of signals (Interface signal and user control signals) precedes the on time of Power (V_{LCD}), it will be happened abnormal display. When T6 is NC status, T6 doesn't need to be measured.
6. If there is no abnormal display, no problem.
7. It is recommendation specification that T8 has to be 100ms as a minimum value.

※ Please avoid floating state of interface signal at invalid period.
※ When the power supply for LCD (VLCD) is off, be sure to pull down the valid and invalid data to 0V.

3-6-2. Sequence for LED Driver

Power Supply For LED Driver



3-6-3. Dip condition for LED Driver

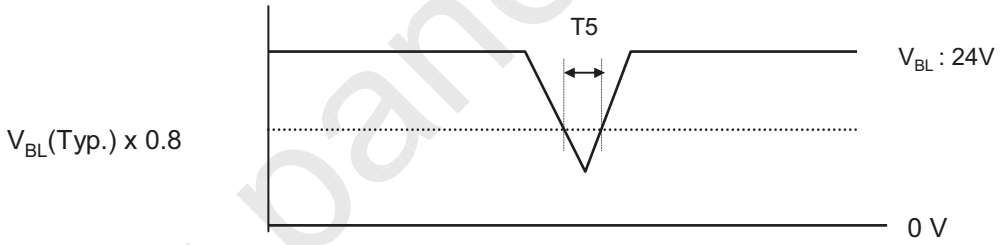


Table 9. Power Sequence for LED Driver

Parameter	Values			Units	Remarks
	Min	Typ	Max		
T1	20	-	-	ms	1
T2	500	-	-	ms	
T3	10	-	-	ms	
T4	0	-	-	ms	
T5	-	-	10	ms	**V_{BL}**(Typ) x **0.8**
T6	500	-	-	ms	2

Notes : 1. T1 describes rising time of 0V to 24V and this parameter does not applied at restarting time.
Even though T1 is over the specified value, there is no problem if I^2T spec of fuse is satisfied.
2. In T6 section, ExtVBR-B should be sustained from 5% to 100% .